... OF CONCRETE PAVEMENT FOR

TRAFFIC STRIPING

By

R. D. Botts*

...nerally recognized that portland cement concrete
... makes efficient traffic striping difficult
... compared to asphalt concrete surfaces. Almost
... paint, regardless of its type and class, will show
...bility on asphalt pavement than on portland cement con-

... probably several factors to consider as reasons
... The one that is generally given most weight by
...e alkaline character of portland cement concrete
... Because of this, paints having saponifiable vehicles will
...ed at the boundary. Water will soften the paint surface
...s saponified and a few cycles of wet and dry con-
...a loosening at the boundary of the two surfaces.
...general failure soon follows.
...feature of portland cement concrete is the tendency to
... to migrate to the surface from below the slab by
... Moisture accumulated under the film of paint is vapor-
...eratures rises with a consequent lifting of the film.
... not so marked in asphaltic concrete and dispersion of

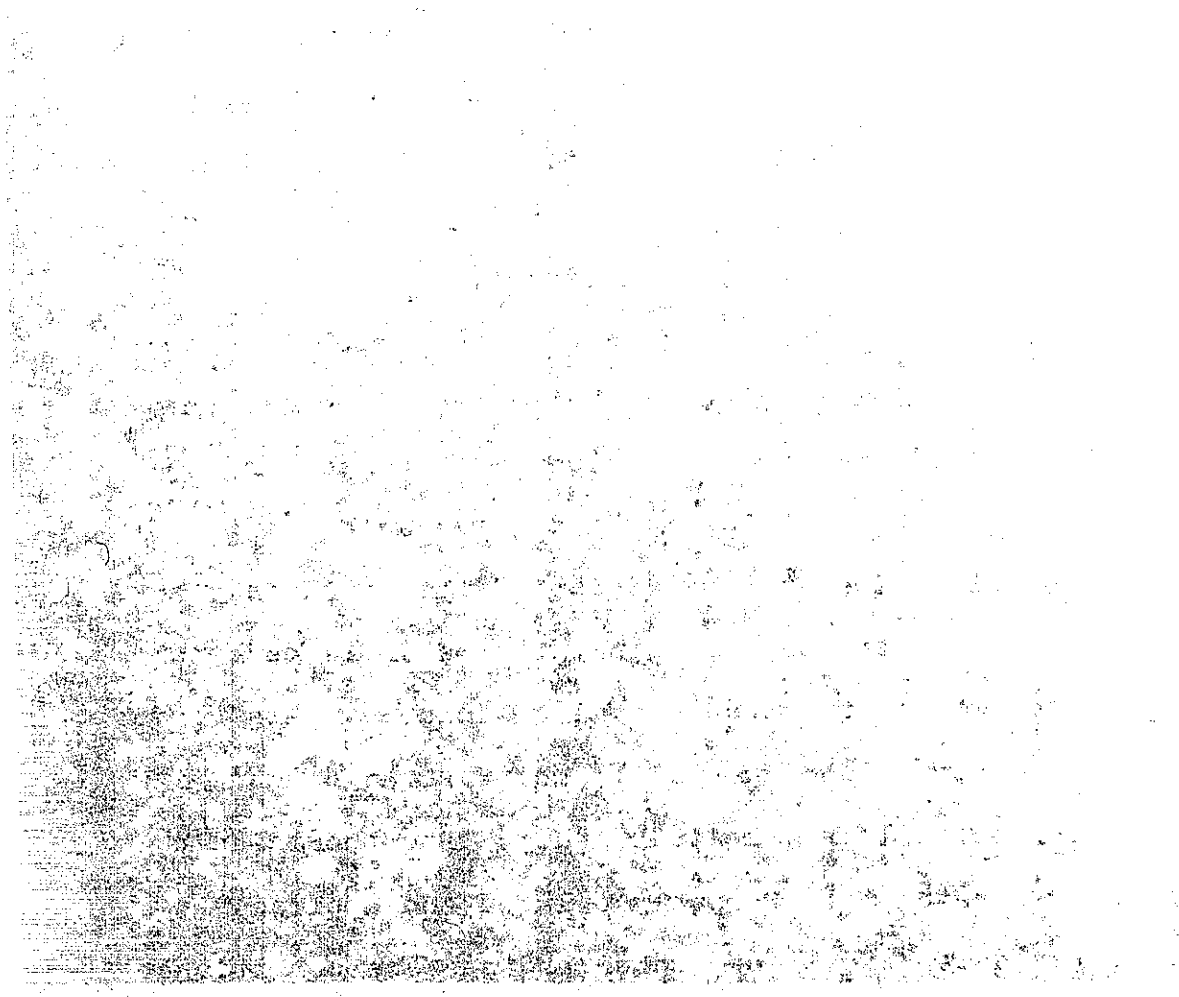
*...ical Testing Engineer, California Division of Highways

rising moisture is greater so that the lifting of the paint film is relatively rare.

Still another feature of portland cement concrete is its tendency to become slick and glass-like under traffic wear. A certain amount of oil may also be absorbed into the surface. Both of these characteristics tend to make adhesion of a paint film less stable than that of the film on the asphaltic surface, where the solvent in the paint "takes a bite" into the asphalt and welds the surfaces of the asphalt and paint together to a certain degree.

It has been the custom to etch concrete surfaces prior to painting for a long time now. The treatment has been used to reduce the alkalinity of the surface as well as to provide a roughened surface whereby adhesion of an applied coat is improved. The acid commonly used has been Hydrochloric. The etching action of this acid leaves nothing to be desired, but a thorough rinsing with water is necessary following such treatment to insure the removal of soluble salts formed by the interaction of concrete and the acid. Most of the common etches require rinses, or at least profit by them. Phosphoric acid, however, is not in this category. Properly diluted and applied, phosphoric acid serves as an excellent etcher and surface conditioner and requires no rinsing. Unlike hydrochloric acid, phosphoric forms no soluble salts when applied to concrete; instead, surface coatings insoluble in water are produced and they are of such character as to be nearly ideal as a base for painting.

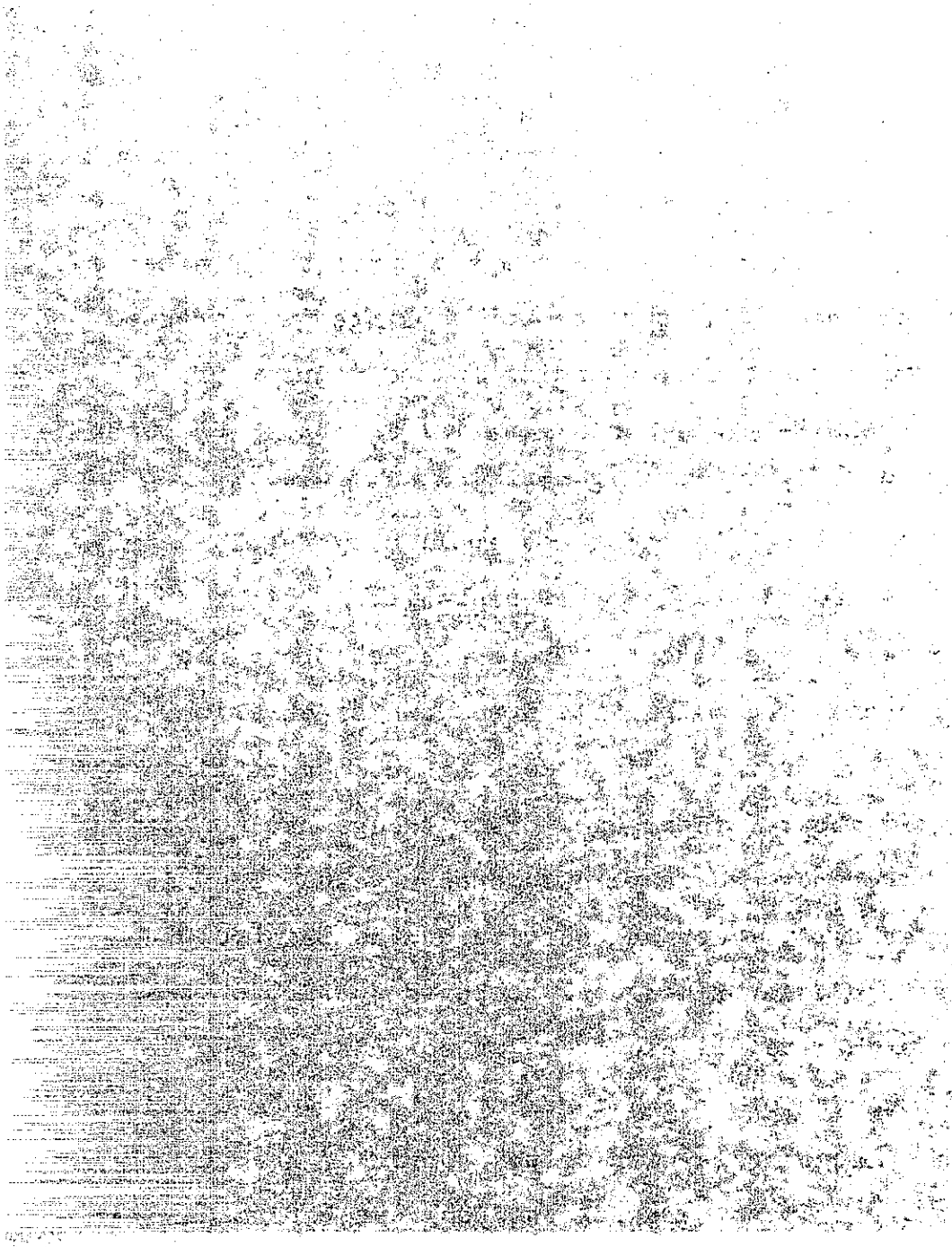
With this in mind, it was decided to try this acid on some sections of pavement in California, where adhesion had been a problem for several years. The first place chosen was the concrete deck of a bridge



where the surface had become highly polished and glazed. A few days after application, paint would break away from the surface and extensive chipping and flaking followed. The surface to be painted was treated with a phosphoric acid solution, corresponding to the diluent of Federal Specifications, MIL-P-15328. This material is about 15% ortho-phosphoric acid in alcohol and water. Application was by bristle brush. When the surface dried, the paint was applied by regular spray technique used by the California Division of Highways.

The results were very satisfactory. There was no appearance of failure for several months. The paint film wore down by abrasion, but the service of the line of this bridge deck has been good since the experiment was initiated about 5 years ago. This bridge has now passed into the custody of the county and is painted once a year. Traffic is about 35,000 vehicles daily. General service of the paint on the portland cement concrete of the bridge deck compared to that on the asphalt approaches on each side, is excellent up to this time.

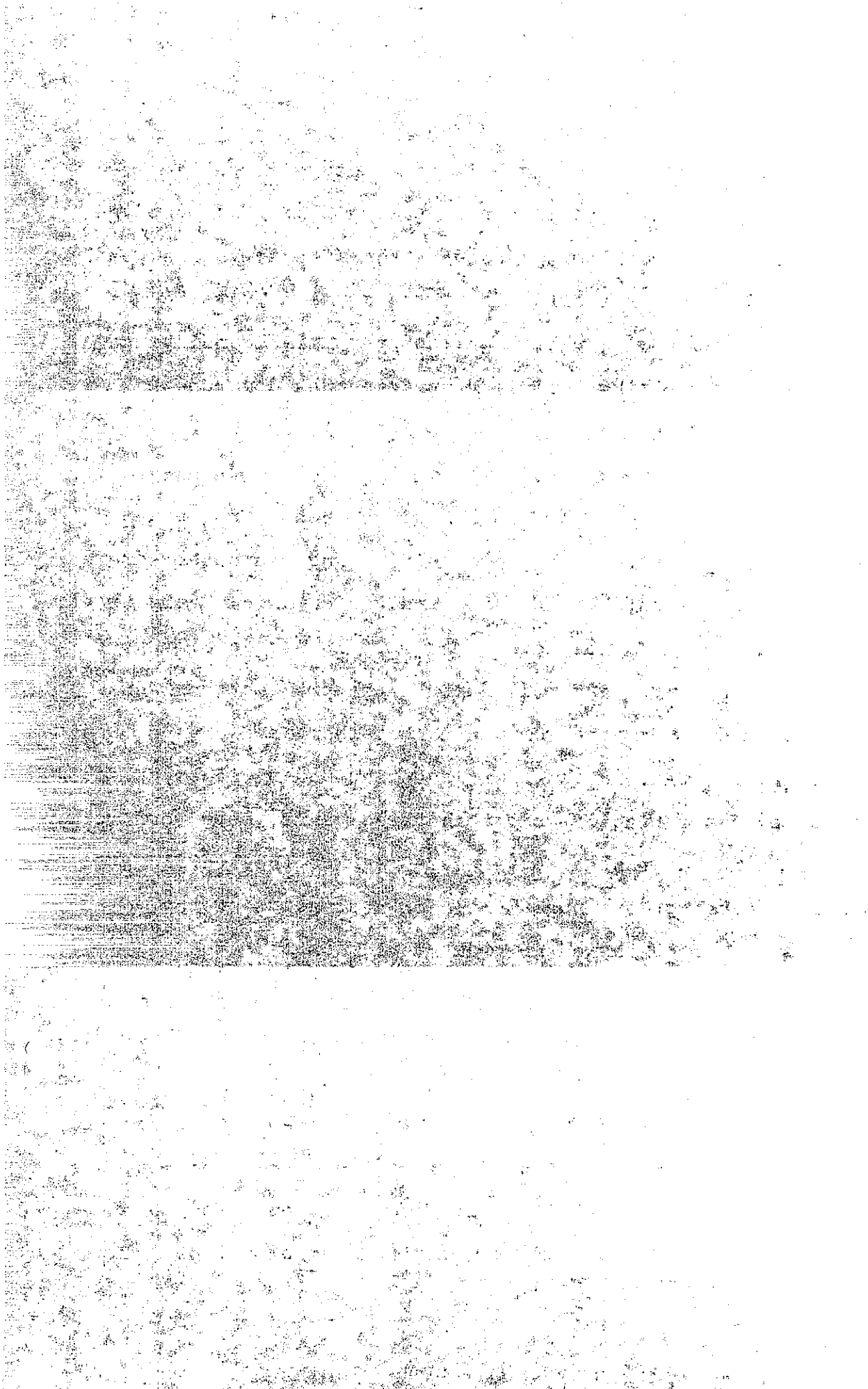
Having noted the success of this experiment, it was deemed appropriate to repeat it on a large scale with proper control. Accordingly, two separate sections of pavement were selected on four lane highways where paint service had been very poor and where controlled sections of similar type were readily available. One of these sections was on a bridge deck, with a history comparable to the one described above. The other section was on an ordinary highway where pea-gravel and sand washed on to the pavement during heavy rains. The traffic paint on both sections and in both directions had given very poor service for several years. At the time of this experiment, the surfaces were almost completely bare and free of paint.



The phosphoric acid solution used in this test was applied by the striping machine in the same manner as paint is applied on pavement in California. After allowing adequate time for drying, a coat of California Specifications Traffic Paint was applied over the phosphated portions, at the rate of 7 gallons per mile, consisting of 3/8 mile of actual striping. Similar striping was done on the non-phosphated section. Beads were dropped into all of the lines at the rate of 40 pounds per mile.

The results of these tests are interesting, even if not conclusive. On the bridge deck where previous painting had never adhered well over a period of years, the adhesion and performance of the traffic stripe was excellent on the phosphated portion. It was equally good on the non-phosphated part. After 17 months, the two sections were repainted when both of them were worn thin, but there had been no flaking and no general failure in the films. Subsequent lines, placed on top of these over a period of more than three years, have worn well. Part of each section traverses a curve where wear on the traffic stripe is very much above that of the normal line on a straight-of-way. These parts of the test sections showed no great deviation from the remainder of the test sections. Traffic density was in excess of 30,000 daily.

The second test, initiated on the same day as the above described, gave concordant results on the control and test sections---both of them poor. There was no significant difference between the control and the experimental sections. Gravel which had washed onto the pavement, was ground into the traffic line paint and did a pretty complete job of removing it within about 3 months from the time of application. The



paint and phosphoric acid used in this part of the test were out of the same tank as that used in the previously described test and were applied on the same day.

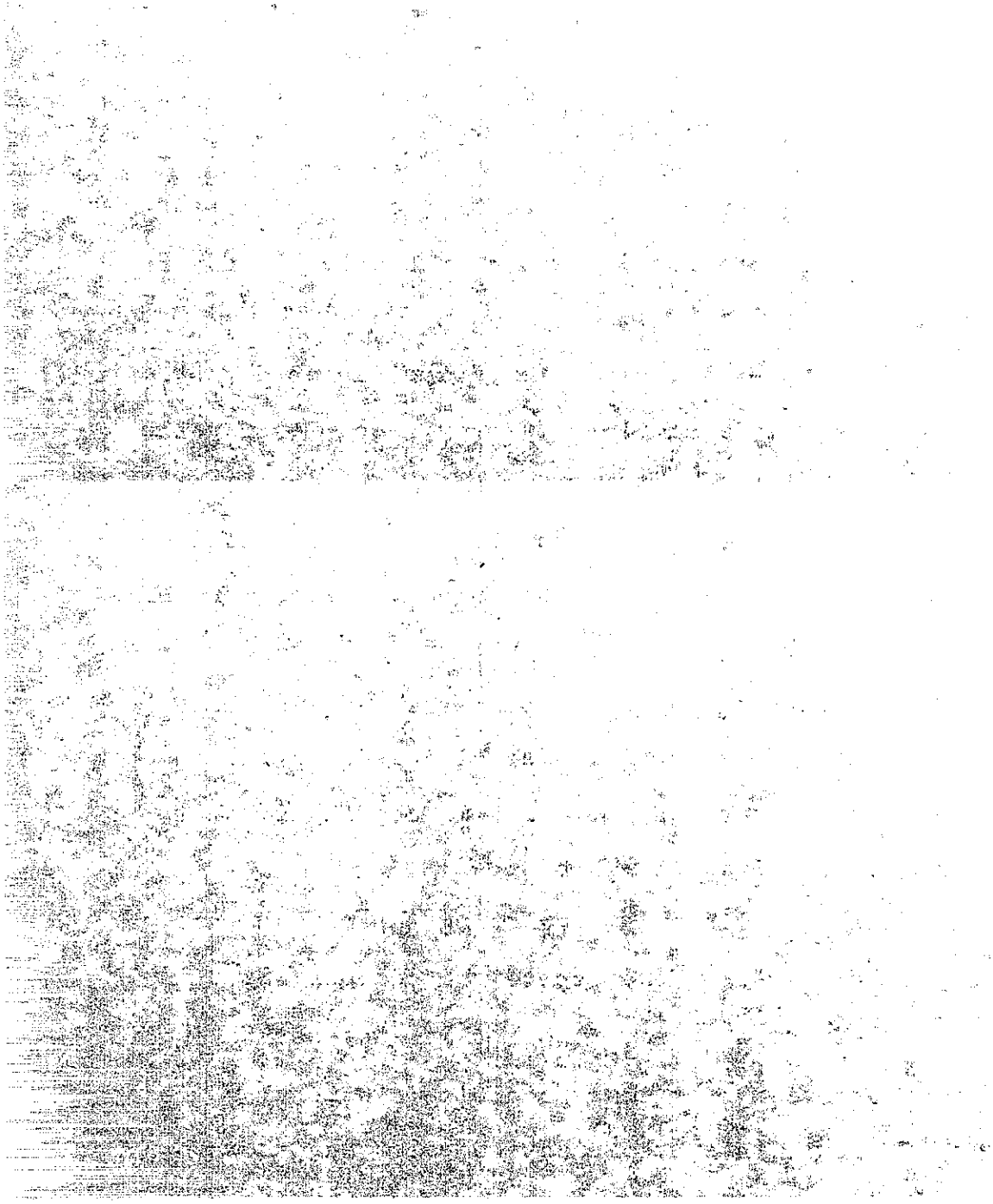
In addition to this large-scale experimentation, a few dozen transverse lines were tested in a similar way over a couple of years time. Many classes of paints were used. The performance of those lines, under which the base had been treated with phosphoric acid, was generally superior to those with untreated bases. There were some notable exceptions from which no consistent pattern could be discerned.

With no significant advantage showing up in the large-scale tests between sections painted with our own specification paint on treated and untreated bases, there was no point in continuing this work further. For the time being, it was dropped.

In the meantime, one of California's painting superintendents, Mr. Leroy Smith of the Los Angeles area, conceived and developed an idea that has been adopted for statewide use. This step was taken after extensive experimentation on a large scale on new portland cement concrete pavements. Our own State specification paint has shown up to 3 years of good performance on pavements which had been given this preliminary treatment.

The following excerpts from a section soon to be entered in the California Highways Maintenance Manual, will serve to describe the procedure used in striping new portland cement concrete pavement.

Quote: "An asphalt line should be applied to new concrete surface 5 to 10 days before the road is open to traffic. Emulsified asphalt is placed in the black tank and applied with the regular striping

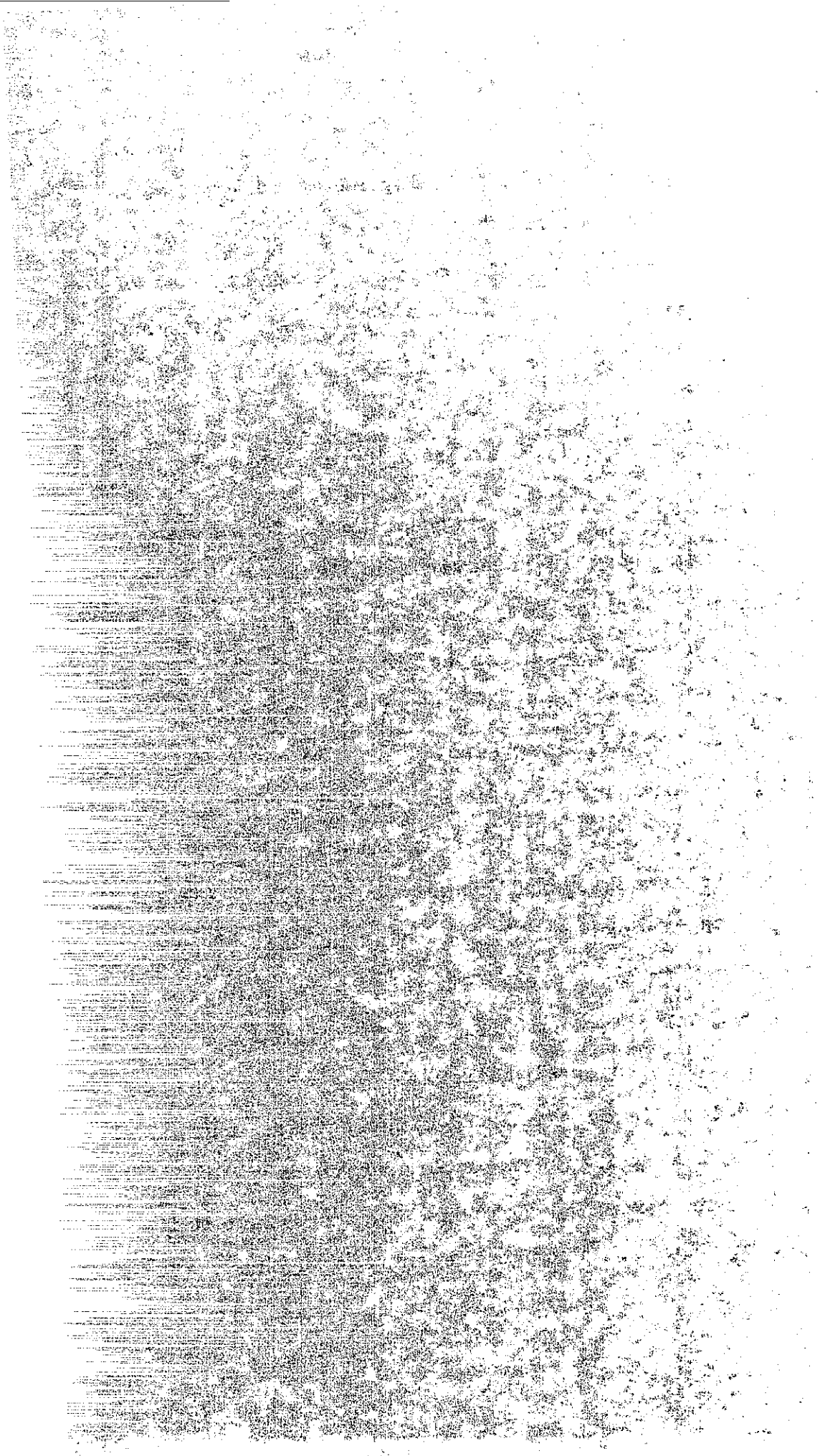


equipment. Sand is placed in a special sand dispenser and applied to the emulsified asphalt line. The secret for success for this line, is to first apply a minimum amount of asphalt and a maximum amount of sand. ... The following material is required to paint a 4" broken line per mile: (equivalent to 3.8 mile solid line)

200 pounds of number 14 to 16 mesh dry sand per mile
8 to 10 gallons of penetration type emulsion type asphalt."

The black tank, mentioned in the paragraph above, refers to a tank in the striping equipment that is reserved for black paint. The sand dispenser is arranged to deliver immediately behind the spray of asphalt as it is applied. No rolling or compaction is necessary under these circumstances, assuming that the viscosity of the emulsion is sufficiently low to encompass the falling sand.

The asphalt specified, shows a non-volatile content of 57 to 62% at 163° temperature Centigrade. A viscosity (Saybolt-Furol) of about 50 is chosen. The line is allowed several days to cure prior to painting. The excess sand is swept off the pavement. The painting of the asphalt base line is then carried out in two steps: First a white coat of 3 or 4 gallons per mile is applied without beads. The California paint dries rapidly enough to avoid bleeding at this rate of application. After the first coat has dried, (a matter of 20 minutes to an hour) a second coat of 7 to 7½ gallons per mile is applied with drop-in-beads at the rate of 40 to 42 pounds per mile. If this procedure is carried out faithfully, there is no bleeding through the surface of the white line. The line durability has been generally quite sufficient to warrant

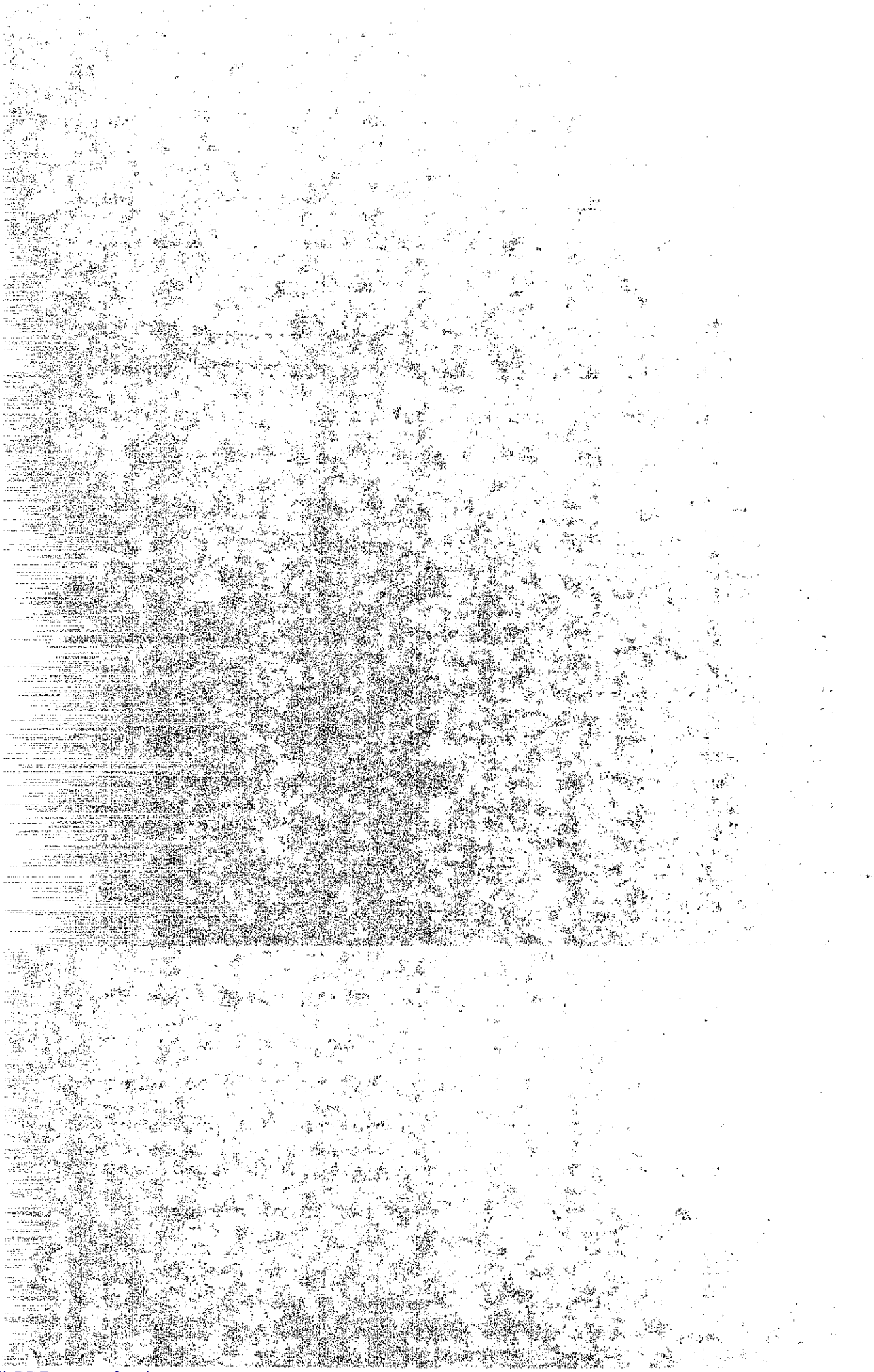


the procedure even as an economy measure.

The number 14 to 16 mesh sand may be difficult to procure in some areas, but it seems reasonable to assume that this restrictive mesh is not critical. We have found it readily available in Los Angeles and that it works very well for us, hence this restriction. It should be re-emphasized that a large excess of sand is mandatory for successful striping. Used with an 8 or 9 gallon application of the emulsion on a broken line, the rise in the surface of the line above the pavement is not significant. There is, of course, some rise, but so far as we have been able to observe, it makes no significant difference in the appearance of the line under wet conditions at night.

DISCUSSION:

It is difficult to account for the anomalous behavior of the phosphoric acid treated lines described in the beginning of this paper. In part, it may have been due to the type of paints used, prior to the experiments. The original paint placed on these spots was probably the California Manila Gum-China Wood oil formula, which was highly acid in character and consequently quite susceptible to neutralizing action at the juncture of the surfaces. Such reaction would reduce adhesion, cause flaking and general failure. The paint used at the time of experimentation was of the chlorinated rubber type, which is quite resistant to saponification and has pretty good adhesion. Transverse lines of the Manila Gum formula showed marked improvement in the durability when placed on the phosphoric acid pretreated base. Generally, the same thing was true of the chlorinated rubber type, though not as markedly so.



From such data as we have, the emulsified asphaltic pretreatment or "foundation stripe" would appear to be an economical and effective procedure. It should be noted, however, that this procedure has been observed in a relatively mild climate with no extreme variations in temperature. There is no reason to expect any great deviation in behavior in a climate of extremes, but it could be different. Some failures have been noted where insufficient sand was dropped into the emulsion, leaving a "fat" stripe. An excess of sand is very important, as it allows time for a complete cure of asphalt before painting is dome.

In California we use a curing compound on the pavement which is usually of the wax type. Generally it is thin, and so far has caused no separation at the surface boundary of the asphalt and pavement that is apparent. There is nearly always a considerable period of traffic by workmen and others on such pavement prior to its being striped. This may or may not be of significance in the behavior of the asphalt as an adhesive.